FIRE-PROTECTION GLASS PANEL WITH A HEAT SHIELDING CHARACTERISTIC

Background of the Invention:

The present invention relates to a fire-protection glass product such as a glass panel for use as a building material to prevent spread and expansion of fire and to assure the safety during escape from fire and, in particular, to a fire-protection glass product having a heat shielding characteristic.

As a glass product called a fire-protection glass, a wire glass, a tempered glass, and a crystallized glass are known and already put into practical use. Such fire-protection glass has heat resistance and not only serves to shield flames and smokes upon occurrence of fire but also serves as a transparent window for assuring an inside view. However, the fireproof glass can not substantially attenuate heat radiation towards an unburnt area. Such heat radiation may cause the spread of fire to a next room and the difficulty in assuring a safe escape route.

In order to shield the heat radiation, proposal has been made of a fire-protection glass product having a multilayer structure comprising two glass plates 1a and 1b with a gel layer 5 interposed therebetween as illustrated in Fig. 1. Upon occurrence of fire, the gel layer 5 foams, i.e., produces bubbles to exhibit a heat shielding characteristic.

However, the above-mentioned fire-protection glass product uses a large amount of a gel material so that a high material cost is required. In addition, since the above-mentioned glass product is large in thickness and heavy in weight, a high construction cost is also required. Moreover, upon

occurrence of fire, the gel layer foams in several minutes to become opaque. This means that the function of assuring the inside view as the transparent window can not substantially be expected.

Summary of the Invention:

It is therefore an object of the present invention to provide a fire-protection glass product which has both fireproof and heat shielding characteristics, which is light in weight and small in thickness to be easily equipped, and which does not require a gel layer.

According to one aspect of the present invention, a fire-protection glass product having a heat shielding characteristic comprises a plurality of fireproof glass plates, a resin intermediate layer interposed therebetween, and a heat-ray reflection film or IR reflection film formed on the surface of at least one of said glass plates. The heat-ray reflection film has a reflectance of 70% or more for a light of the wavelength of 2500nm and an average transmittance of 60% or more for visible rays.

At least one of the fireproof glass plates may be made of a heat-resistant transparent crystallized glass.

In the fire-protection glass product according to this invention, the heat-ray reflection film, which is transparent, is formed on one or both of opposite surfaces of at least one fireproof glass plates. With this structure, heat rays produced upon occurrence of fire are reflected by the heat-ray reflection film to suppress heat emission and to attenuate heat radiation to the next room. Furthermore, a resin material used as the intermediate layer is darkened by temperature rise upon occurrence of fire and absorbs the heat rays. At usual times, the fire-protection glass product of this invention serves as a safety glass by provision of the intermediate layer which prevents shattering or scattering of cracked glass pieces when the glass product is damaged or broken by collision or impact.

The heat-ray reflection film has a reflectance of 70% or more for a light of a wavelength of 2500nm. Upon occurrence of fire, the temperature of a burnt area falls within a range between 800℃ and 900℃. At this time, an energy distribution of the heat ray radiated therefrom corresponds to a light of a wavelength of 2000 to 3000nm. If the heat-ray reflectance is 70% or more for a light of the wavelength of 2500nm, the heat-ray reflection film reflects the heat radiation upon occurrence of fire and sufficiently suppresses heat radiation into the unburnt area. On the other hand, if the heat-ray reflectance is 70% or less for a light of the wavelength of 2500nm, the heat-ray reflection film cannot substantially attenuate the heat radiation so that heat-shielding characteristic is insufficient. The heat-ray reflection film has such a spectral characteristic or a light selectivity that it has reflectance of 70% or more, 50% or more, and 80% or more for spectra lights of wavelengths of 2500nm, 1500nm and 3000nm, respectively.

The heat-ray reflection film has an average transmittance of 60% or more for visible rays (400nm to 700nm). If the average transmittance for the visible rays is less than 60%, light transparency of the film is so low so that a sufficient range of view or sight cannot be assured through the glass panel with the film. This deteriorates the function of the glass panel as a window. Preferably, the heat-ray reflection film has an average reflectance of 15% or less for visible rays.

As the heat-ray reflection film having the above-mentioned characteristics, use is most preferably made of an indium oxide film containing tin, an antimony oxide film containing tin, a tin oxide film containing fluoride, or a tin oxide film containing antimony. Alternatively, a ZnO-based transparent film can also be used. These films can be deposited on the glass plate by sputtering, spraying, dipping, or the like.

The heat-ray reflection film has a thickness between 1000Å and 15000Å. If the thickness is not greater than 1000Å, the heat-ray reflectance at the wavelength of 2500nm tends to fall within the range not greater than 70%. If the thickness is not smaller than 15000Å, the average transmittance for visible rays tends to fall within the range not greater than 60%.

As the fireproof glass plate, use may be made of a low-expansion crystallized glass, a borosilicate glass, a strengthened glass, and the like, alone or in combination. In particular, the low-expansion crystallized glass is preferable as the glass plate because it is resistant against the fire continuing for a longer time period and does not break even if it is sprayed with water by a sprinkler.

RAA 4/27/01

Upon occurrence of fire, the resin intermediate layer serves to absorb heat rays because the resin material is carbonized (blackened) by incomplete combustion. At normal times, the resin intermediate layer serves to assure the safety by preventing the release and the drop of the glass pieces when the glass plate is broken. As the resin material, use may be made of fluorocarbon resin, polycarbonate resin, polyethylene terephthalate resin, and the like.

In order to achieve a higher heat shielding characteristic, the fire-protection glass product may have a double-glazing structure including an additional glass plate attached through an air layer. The fireproof glass plate may be combined with a soda-lime glass plate.

Now, embodiments of this invention will be described in detail with reference to the drawing.

Brief Description of the Drawings:

Fig. 1 is a sectional view of a conventional fire-protection glass panel having a gel layer;

Fig. 2 is a sectional view of a fire-protection glass panel according to an embodiment of this invention; and

Fig. 3 is a sectional view for describing a multilayer glass panel using the fire-protection glass panel illustrated in Fig. 2.

Description of the Preferred Embodiments:

Description will now be made as regards embodiments of this invention with reference to the drawing.

As illustrated in Fig. 2, a fire-protection glass panel having a heat shielding characteristic comprises two fireproof glass plates 1a and 1b, a resin intermediate layer 2 interposed between the glass plates 1a and 1b, and a heat-ray reflection film 3 formed on an outer surface of the fireproof glass plate 1a. The heat-ray reflection film 3 has a reflectance of 70% or more for a light of the wavelength of 2500nm and an average transmittance of 60% or more for visible rays.

Referring to Fig. 3, a multi-layer glass panel comprises the fire-protection glass panel illustrated in Fig. 2 and an additional fireproof glass plate 1c with an air layer 4 interposed therebetween. This structure achieves a higher heat shielding characteristic. The fireproof glass plate may be combined with a soda-lime glass plate.

Now, specific examples of the fire-protection glass panel of this invention will be described in detail together with comparative examples.

Example 1

At first, preparation was made of two heat-resistant transparent crystallized glass plates (FIRELITE manufactured by Nippon Electric Glass Co., Ltd.) each of which has a dimension of $950 \times 600 \times 4$mm and a thermal expansion coefficient of -5×10^{-7}/℃.

Subsequently, an ITO (indium-tin oxide) film was deposited onto one surface of one of the glass plates by the use of a sputtering apparatus at a temperature of 350℃. The ITO film had a thickness of 4000Å.

Then, each glass plate was cut into a sample piece having a dimension of 900×600×4mm. Using the sample piece, the spectral characteristic of the glass plate after the above-mentioned deposition was measured by the use of a spectrophotometer. Herein, the reflectance was measured as a total internal reflectance using an integrating sphere while the transmittance was measured without using the integrating sphere.

As a result, the reflectance for a light of the wavelength of 2500nm was equal to 95% and the average transmittance for visible rays was equal to 81%. Thus, these values were preferable as external appearance of the film.

Subsequently, as a resin intermediate layer, preparation was made of a fluorocarbon resin film comprising a copolymer containing 40 weight% of tetrafluoroethylene (TFE), 20 weight% of hexafluoropropylene (HFP), and 40 weight% of vinylidene fluoride (VDF) and having a chain molecular structure. The film had a thickness of 500 μm. The resin film was placed between the fireproof glass plates and subjected to thermo-compression bonding to obtain the fire-protection glass panel as illustrated in Fig. 2. The thermo-compression bonding was carried out by holding the resin film at a predetermined temperature for 15 minutes under a pressure of 1.27MPa.

<u>Example 2</u>

Preparation was made of two tempered borosilicate glass plates having a dimension of 950×600×4mm, similar to that of Example 1.

Subsequently, one of the glass plates was heated by an electric furnace to a temperature of 600℃. Then, stannic chloride solution containing 1% antimony was applied onto one side surface of the above-mentioned glass plate by the use of a spraying device to deposit an antimony-containing tin oxide film. The tin oxide film thus obtained had a thickness of 2500Å.

In the manner similar to that mentioned in conjunction with Example 1, measurement was made of the spectral characteristic of the glass plate after

the above-mentioned deposition. As a result, the reflectance for a light of the wavelength of 2500nm was equal to 78% and the average transmittance for visible rays was equal to 74%. These values were preferable as external appearance of the film.

Thereafter, as the resin intermediate layer, preparation was made of a polyethylene terephthalate resin film having a thickness of 200 μm and having adhesive layers formed on opposite surfaces thereof. By the use of the resin film, the two glass plates were adhered to each other to obtain the fire-protection glass panel as illustrated in Fig. 2.

Comparative Example

For the purpose of comparison, preparation was made of a tempered borosilicate glass plate similar to that in Example 2.

Then, in the manner similar to Examples mentioned above, measurement was made of the spectral characteristics of the glass plate. As a result, the reflectance for a light of the wavelength of 2500nm was equal to 7% and the average transmittance for visible rays was equal to 85%.

Evaluation

Each sample of Examples 1 and 2 and Comparative Example was subjected to a heat-shielding test.

The heat-shielding test was performed in the following manner. At first, each sample was fixed to a frame at its end surfaces so as to avoid the end surfaces from being heated, and was arranged in front of a flat heating furnace. Then, the sample was heated in accordance with a standard heating curve provided in the Official Notification No.1125 of the Ministry of Construction of Japan. By the use of a heat flow sensor located at a distance of 0.5m from the center of an unheated surface of the sample, the maximum heat received thereat (W/cm^2) was measured after lapse of 60 minutes. Those samples of Examples 1 and 2 were tested for a case A in which the heat-ray reflection film

was positioned on a heated side or a side facing the heating side and a case B in which the heat-ray reflection film was positioned on the opposite or unheated side. The results are shown in Table 1.

Table 1

	Example 1	Example 2	Comparative Example
Reflectance Average for Visible Rays	12	19	6
1500nm	60	55	6
2500nm	95	78	7
3000nm	98	83	7
Transmittance Average for Visible Rays	81	74	85
1500nm	8	15	86
2500nm	3	18	87
3000nm	2	15	88
Heat Received (W/cm^2)			
Case A	1.0	1.2	3.1
Case B	1.1	1.3	-

As is obvious from Table 1, each of the Examples exhibited the heat received as low as 1.0-1.3W/cm^2 after lapse of 60 minutes (925℃) after start of heating. Furthermore, each of the Examples was maintained for more than about 15 minutes after start of heating to allow the other side to be seen through it.

For a conventional fire-protection glass panel (manufactured and sold by SAINT-GOBAIN CERAMIQUES IND. (FRANCE) under the trade name of CONTRAFLAM) which comprises the gel layer 5 interposed between two glass

plates 1a and 1b as illustrated in Fig. 1, the similar heat shielding test was performed. As a result, the heat received was sufficiently low but foaming of the gel layer 5 occured so that the other side can no longer be seen through it after lapse of about 4 minutes after start of heating.

In the fire-protection glass product according to this invention, the heat radiation upon occurrence of fire is reflected by the heat-ray reflection film and absorbed by blackening of the resin layer interposed between the glass plates. Therefore, the fire-protection glass product has high heat-shielding characteristic. This suppresses the probability of combustion or ignition of matters present in a room adjacent to the fired room to thereby prevent the spread of fire. In addition, it is possible to assure a safe escape route upon occurrence of fire. Furthermore, since the light transparency can be maintained for a predetermined time duration, the status of fire can be visually confirmed to thereby facilitate lifesaving and fire fighting. Moreover, the fire-protection glass product according to this invention is thin in thickness, light in weight, and low in construction cost and is therefore advantageously used as a building material.